A Flexible 8-Channal Digitizer Board for GRETA

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The next generation of highly segmented germanium detectors, such as GRETA (Gamma-Ray Energy Tracking Array), will require fast, inexpensive digitizers capable of performing real-time data reduction, analysis, and triggering. A 12-bit amplitude conversion and sampling rates of 100 MHz are required for good energy resolution and to preserve the position and time resolution required for the ~5000 channels in a 40-module array. To demonstrate the feasibility of such a system an 8-channel, 100 MHz, 12-bit ADC board was designed and constructed in 2002 (figure 1). Unlike some commercially available ADC boards, which perform only waveform digitization, the GRETA prototype board is capable of performing real-time digital signal processing with a functionality equivalent to standard analog electronic systems for Ge detectors. Currently implemented functions include:

- A leading edge discriminator employing a binomial filter to generate internal triggers.
- A constant fraction discriminator to provide energy-independent timing.
- An energy algorithm, which employs a user adjustable trapezoidal filter to optimize S/N for energy determination.
- A user adjustable window to extract relevant parts of the pre-amplifier pulse for subsequent signal decomposition.

Also provided on the board are three trigger modes (internal, external, and combined) for each channel allowing maximum flexibility. Readout of the prototype ADC board is carried out over a VME bus to simplify integration into current data acquisition systems, and is designed for a sustained counting rate of 10 kHz, typical of in-beam experiments. The readout for the final system, which will have a higher channel density, will use a much faster data transfer system.

The design and construction of the 8-channel board has been successful and included full simulations of the complex VHDL code used to implement the above functions. The ability to carry out the required signal processing on a single large FPGA without the need for a dedicated on-board CPU or DSP has considerably reduced the cost and development time for this project. More 8-channel boards will be fabricated and fifteen of them will be integrated in a 120-channel acquisition system required for the three-crystal GRETA module prototype (see separate contribution). This board meets the specifications outlined at the digital electronics workshop held in Argonne (2001) for a general-purpose digital signal processing board for the low-energy nuclear physics community and will serve as the prototype for a more complex 40 channel ADC board required for the final GRETA array.

Footnotes and References

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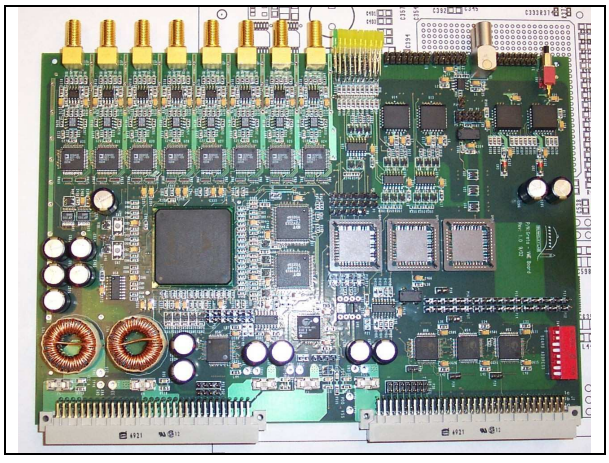

Fig. 1. The 8 channel prototype digital processing board